

## CO FRA-04 Compressed Gas Transportation and Use

<b>Risk Team Members:</b> (BNL Team) P. Carr, R. Sabatini, D. Cabelli, A. Ackerman, J. Peters, A. Piper, R. Selvey	<b>Point Value → Parameter ↓</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
<b>Name(s) of Chemistry Department Risk Team Members:</b> Diane Cabelli, Richard Hahn, Jan Hrbek	<b>Frequency (B)</b>	≤once/year	≤once/month	≤once/week	≤once/shift	>once/shift
<b>Job Title:</b> Compressed Gas Transportation and Use  <b>Job Number or Job Identifier:</b> FRA04	<b>Severity (C)</b>	<b>First Aid Only</b>	<b>Medical Treatment</b>	<b>Lost Time</b>	<b>Partial Disability</b>	<b>Death or Permanent Disability</b>
<b>Job Description:</b> Transport and Work with compressed gas cylinders and systems, including flammable/toxic gases	<b>Likelihood (D)</b>	<b>Extremely Unlikely</b>	<b>Unlikely</b>	<b>Possible</b>	<b>Probable</b>	<b>Multiple</b>
Approved by: Diane Cabelli                      Date:5/10/2013						
Rev. #: 3						
<b>Stressors (if applicable, please list all):</b>		<b>Reason for Revision:</b> Added lesson learned about lifting cylinder by cap. <b>Rev 2:</b> Added lessons learned about collapsing cylinder cart <b>Rev 3:</b> Removed 901, 906 and 560 from FRA			<b>Comments:</b>	

				Before Additional Controls							After Additional Controls					
Job Step / Task	Hazard	Control(s)	Stressors Y/N	# of People A	Frequency B	Severity C	Likelihood D	Risk* AxBxCxD	Control(s) Added to Reduce Risk	Stressors Y/N	# of People A	Frequency B	Severity C	Likelihood D	Risk* AxBxCxD	% Risk Reduction
Storage of gas cylinders at bulk storage area (555)	Being struck by object due to pressure release	Cylinder certification, storage area conditions, cylinders capped and secured	N*	1*	3*	4*	1*	12*								
	Exposure to highly toxic gases	Bulk storage area vented (555), No highly toxic gases stored indoors at 901	N	1	3	4	1	12								

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	Explosion or fire due to ignition of gas	Storage area conditions, cylinder certification, separation of fuel and oxidizer cylinders (oxygen behind wall in 555), cylinders capped and secured	N	1	3	5	1	15								
Transporting cylinders from storage to use area or use area to storage	Overexertion injuries caused by excessive lifting, pushing, pulling, holding, carrying	Wheeled gas carts, training, cylinders secured	N	1	3	3	3	27	See attached lesson learned. Do not lift cylinder by cap. <b>See attached lessons learned: inspect cylinder carts before use.</b>							
	Being struck by object due to pressure release from failure of equipment (likely rolling cart collapse)	Cylinder design/certification, cart inspection prior to use and removal of three-wheeled carts, training, cylinders capped and secured during transport	N	1	3	4	2	24								
Moving cylinders to different floor level in elevators	Being struck by object due to pressure release from falling of cylinder or inhalation exposure	Wheeled gas carts with cylinders secured; cylinders capped and secured; no personnel in elevator during floor changes, use freight elevator unless it is out-of-service. Have person to receive cylinder on other floor	N	1	3	4	1	12								

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Attaching regulator to cylinder	Being struck by object due to pressure release; gas release, Explosion due to improper regulator (e.g., oiled regulator on oxygen cylinder)	Regulator design/certification, equipment inspection, safety glasses with side shields, training, cylinders secured, no use of adaptors, making sure that valve on cylinder is securely closed before attaching regulator.	N	1	3	4	2	24								
Connecting regulated cylinder to system	Being struck by object due to pressure release	Cylinder/regulator design/certification, equipment inspection, training, system design/review-ensuring that regulator and adaptors to the system are pointed so they will not cleave if hit, isolation valves, cylinders secured, safety glasses	N	1	3	4	2	24								
Connecting regulated cylinder to system	Fire	Use of flash protectors on flammable gases, Tier 1	N	1	3	5	1	15								
Storing gas cylinders in use areas	Being struck by object due to pressure release; gas release	Cylinders capped and secured	N	1	3	4	1	12								
Use of compressed gases	Being struck by object due to pressure release	Design of system, pop-off valves	N	1	3	4	1	12								

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	Contaminated or mislabeled cylinder	User check for signs of cylinder content error; QA specifications where contamination can be hazardous	N	1	3	3	3	27								
	Oxygen deficiency	System design/review, ventilation, ODH review, Tier 1	N	1	3	5	1	15								
	Poisoning or lung damage due to inhalation of toxic gas	System design/review-use of metal tubing where appropriate, inspection of tubing at frequent intervals, MSDS, ventilation, Tier 1, Use of smallest amount feasible, use of ballasts that are filled from main tanks and the main tanks then are closed off.	N	1	2	5	2	20								
Use of flammable or oxidizing gas (in addition to above hazards)	Explosion or fire due to ignition of gas; failure of flexible lines	System design/review, MSDS, ventilation, checking of flexible tubing on Tier 1, gas compatibility, cylinders secured, removal of heat or spark sources,	N	1	2	5	1	10								
	Contaminated or mislabeled cylinder causing fire or explosion	User check for signs of cylinder content error; QA specifications. Regulator connections are specific enough to add a layer of protection.	N	1	2	5	1	10								

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	Explosion or fire due to reaction of gas with surroundings	System design/review, MSDS, ventilation, Tier 1, OSHA compliance, segregation of materials	N	1	2	4	1	8								
Use of fuel-gas system for glassblowing	Explosion or fire due to improper gas mixture, leaking hoses, nozzles or valves	Equipment inspections, Tier 1, training, segregation when not in use	N	1		4	1	16								
	Fire due to ignition of surrounding materials or clothing	Area inspections, Tier 1, training, fire retardant labcoats.	N	1		2	3	24								
	Contact with heated objects resulting in burns	Work area conditions, Tier 1, training, gloves, proper tools or tongs	N	1		2	3	24								
Disconnecting gas supply from system	Being struck by object due to pressure release, toxic fumes	equipment inspection, training, system design/review, isolation valves, safety glasses, cylinders secured	N	1	3	4	2	24								
Removing regulator from cylinder	Being struck by object due to pressure release	Cylinder/regulator design/certification, equipment inspection, training, system design/review, safety glasses, cylinders secured, making sure that valve on cylinder is securely closed before removing regulator	N	1	3	4	2	24								
Testing and changing parts on regulators			N	1	2	4	1	8								

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Adding flame arresters to regulator			N	1	2	4	1	8								
Further Description of Controls Added to Reduce Risk:																
*Risk:	0 to 20 Negligible	21 to 40 Acceptable	41 to 60 Moderate					61 to 80 Substantial			81 or greater Intolerable					

## **CO FRA-04 Compressed Gas Transportation and Use**

### **Lessons Learned Statement:**

Personnel responsible for compressed gas cylinders must be aware of loose valve protection cap fittings on gas cylinders before handling. Replace caps on empty or unused gas cylinders with the appropriate threads (i.e. coarse threads with coarse threads or fine threads with fine threads) to protect the cylinder valve and the employees moving/handling the cylinders.

### **Discussion of Activities:**

Two experienced material clerks at Oak Ridge National Laboratory (ORNL) were making an emergency delivery of compressed gas cylinders to a cylinder rack in a nearby location. Before the full gas cylinders could be placed in the cylinder racks, the empty cylinders had to be removed from the racks. The material clerk removed one cylinder from the 2-inch pocket by lifting the cylinder by its cap. The cap came off and struck him in the mouth and nose. He experienced bleeding from the nose, extreme pain, and trouble with his vision. The employee was wearing safety glasses and safety shoes. The employee was treated and released from medical services and returned to work the following day.

### **Analysis:**

The cylinder racks were made of heavy plastic material, and each rack included ramps to roll the cylinders onto the racks. The rack was designed with six 2-inch deep pockets for storage of six cylinders. Straps for each cylinder were also attached to the rack. Prior to removing an empty cylinder from one of the pockets, the material clerk checked the cylinder cap to ensure it was secure and tight and also checked for any bees.

The racks were purchased approximately a year ago but were not designed like other cylinder racks throughout the site. When removing cylinders from other cylinders racks, the materials clerks can roll the cylinders out of the rack and do not have to lift a cylinder by its cap to remove it from a rack. Since the material clerk was not able to lift the cylinder by the cylinder's body, he had to lift the cylinder by the cap to clear the 2-inch pocket. The cap on the cylinder was a coarse thread cap on a fine thread neck which caused the cap to come off the cylinder when lifted.

### **Recommended Actions:**

1. Evaluate the gas cylinder rack design to ensure functionality and safety.
2. Although the valve protective cap may appear to be secure and tight by touch, a tap or side force may release the cap if the cap threads and cylinder threads are of different sizes.
3. A little corrosion/rust can make the cap feel secure, but it may not be tight.
4. This information should be disseminated for review by persons responsible for compressed gas cylinder storage areas

## **CO FRA-04 Compressed Gas Transportation and Use**

### **Lessons Learned Statement:**

Compressed gas cylinder carts must be inspected before each use to make sure they are not defective. Improper cylinder cart design and useage can cause mishaps.

### **Discussion of Activities:**

At New Brunswick Laboratory a cylinder cart capable of being used as a two or four wheel cart had a locking mechanism that malfunctioned causing the cylinder cart to collapse with the cylinder hitting the ground. The cylinder was capped and chained to the cart.

### **Analysis:**

The employee had not inspected the cart before use and the locking mechanism knob had become partially unscrewed. Poor design of the cart as well as failure to inspect the cart before use for possible defects led to the mishap. Also, the chain holding the cylinder to the cart was not tight enough to prevent the cylinder from slipping off the cart.

### **Recommended Actions:**

1. Employees must carefully inspect cylinder carts before using.
2. Employees should be cautioned not to use defective equipment.
3. All employees should receive training on how to use compressed gas cylinder carts.
4. Cart design should be reviewed to determine if durable and likely to break.